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THE INPUT-OUTPUT MODEL WITH RESOURCE CONSTRAINT EXTENSION

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ABSTRACT
In this paper, we inspired by optimization of margin distributions theoretical result, which can maximize the mean and simultaneously minimize the variance. Then, the Lagrangian algorithm approach is presented to solve the problem.

KEYWORDS: input-output model; mean; variance; Lagrangian algorithm

INTRODUCTION
Input–output method is the name given to an analytical framework developed by professor Wassily Leontief more than half a century ago in the 1930s. The terms Leontief model and interindustry analysis are also used to refer input–output methods.

It is well known that input-output analysis traditionally focused on industry interactions and, by extension, industrial policy. Since the fundamental purpose of the input–output framework is to analyze the interdependence of industries in economy, input–output analysis is one of the most widely applied methods in economics.

In the past several decades, the widespread availability of high-speed digital computers has made Leontief's input–output analysis a widely applied and useful tool for economic analysis at many geographic levels and it has been also extended to be part of an integrated framework of employment and social accounting metrics associated with industrial production and other economic activity. Moreover, this method is used to accommodate such topics as international and interregional flows of products and services or accounting for energy consumption and environmental pollution associated with interindustry activity. Although the input–output methods have a long history of literatures, there are still great efforts on improving it to be optimized.

In the paper, we inspired by optimization of margin distributions theoretical result [1], which ties to maximize the mean and simultaneously minimize the variance. Then, the Lagrangian algorithm approach is presented to solve the problem.

The rest of the paper is contained as follows. In part 2, we describe the input-output model and main concept. In part 3, the optimization problem is derived, which helps us to find the optimum with resource constraint. In closing, in part 4 we presents the conclusion and future research work.

INTRODUCE MODEL
Let X denote the column vector of gross outputs, $X = (X_1, X_2, \cdots X_n)^T$ **,and**, $Y = (Y_1, Y_2, \cdots Y_n)^T$ is the final products.

Per-unit price for each sector's output is defined as $P = (P_1, P_2, \cdots P_n)^T$. Here, $A = \begin{bmatrix} a_{11} & a_{12} \cdots & a_{1n} \\ a_{21} & a_{22} \cdots & a_{2n} \\ \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} \ldots & a_{nn} \end{bmatrix}$, is a technical coefficient and the input-out model is defined as follows：

$$X = AX + Y$$

We can get the transfer value of unit output as follows.

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$$A^TP = \begin{bmatrix} a_{11} & a_{21} \cdots & a_{n1} \\ a_{12} & a_{22} \cdots & a_{n2} \\ \vdots & \vdots & \vdots \\ a_{1n} & a_{2n} \cdots & a_{nn} \end{bmatrix} \begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_n \end{bmatrix} = \begin{bmatrix} p_1a_{11} + p_2a_{21} + \cdots + p_na_{n1} \\ p_1a_{12} + p_2a_{22} + \cdots + p_na_{n2} \\ \vdots \\ p_1a_{1n} + p_2a_{2n} + \cdots + p_na_{nn} \end{bmatrix}$$

New created value of unit output value is denoted as $N = (N_1, N_1, \dots, N_n)^T$.
So, we can get the objective function of linear programming for gross product by using this equation $\max \pi = P^T(I - A)X$. And resource constraint is given by $RX \le \overline{R}$. Here, R is resource technical coefficient, $\overline{R}$ is the ownership of resources.

MODEL DEVELOPMENT

In this study, we use the optimization of margin distributions in theoretical result [1], which ties to maximize the mean and simultaneously minimize the variance. Then, the Lagrangian algorithm approach is presented to solve the problem In order to improve this model, we first introduce Lemma 1 below:
Lemma 1. The maximized cost function can be denote as
$f(x) = \mu - \frac{1}{2}\sigma^2$, here μ is the mean, and, σ is the variance.
Lemma 1 has been introduced by Chunhua Shen and Hanxi Li (2010).

Follow the lemma 1, the constraint can be improved to be

$$\max \overline{R} - RX - \frac{1}{n}X + \frac{1}{2n}\delta^T H \delta$$

Our purpose is to maximize the resource constraint ($RX \le \overline{R}$) to maximize the objective function, so by introducing multiple λ and utilization of Lagrangian algorithm, the problem can be written as

$$\max L = P^T(I - A)X + \lambda(\overline{R} - RX - \frac{1}{n}X + \frac{1}{2n}\delta^T H \delta)$$

CONCLUSION AND FUTURE WORK

In this paper, we extends classical input-output model to consider the resource constraint, an improved *equation is presented and* Lagrangian algorithm developed to solve this problem. The improved approach can be used in different economic analysis.

This proposed model is based on Gaussian distributions, so the performance in different distribution maybe varies depends on the type of distribution used to implement that is what we look in future. Moreover, we assumed the per-unit price for each sector's output is known, so another extension is to consider as model without knowing pricing.

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